other important advantage is that by locating the compressor equipment in the basement or cellar, there is usually a greater accessibility for inspection and repairs than there would be in a cabinet. The only important disadvantage of this method of installation is that it makes of the refrigerator equipment a permanent installation compared with the portability of a refrigerating equipment in which the compressor, condenser, and electric motor are all located in the cabinet.

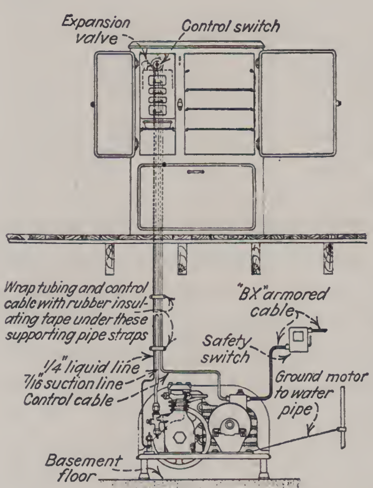

FIG. 151.—Typical remote installation of household equipment.

When the compressor, condenser, and electric motor are installed separate from the refrigerator cabinet in a basement or cellar, precautions should be taken to select a location which is as clean as possible, and the group should be placed so that no water may accidentally be splashed upon them. They should preferably be on a platform sufficiently raised above the floor to avoid the possibility of being flooded if water enters the basement.

A diagram of a typical remote installation for a household refrigerator is shown in Fig. 151. It will be noted that the control switch (p. 174) and expansion valve (p. 173) are marked at the top of the diagram.

Portable Refrigerating Units.—The popularization of mechanical refrigeration created demands for small refrigerating units which do not depend on "outside" sources of energy. For this demand, portable and semi-portable absorption (p. 19 devices have been developed; the device consisting essentially of a "hot ball" and a "cold ball." When in operation to produce refrigeration, the hot ball is exposed to the air and acts as the *absorber* of the refrigerating system, the cold ball being then the *evaporator*.

The history of portable absorption machines goes back to 1865, when Carré brought out a device of this kind in France. Little was done in the commercial development of this type of refrigeration until about 1925, when such a refrigerating device was made

commercially available in that country and, about 2 years later, also in the United States. A typical French machine of this type is shown in Figs. 152 and 153. As illustrated in Fig. 153 it operates on the "intermittent"-absorption cycle in which aqua ammonia is heated in the boiler B (generator and absorber), the refrigerant gas passing up around the baffles b and through the tube T_1 to the "cooler" A (condenser and evaporator), where the condensation of the vapor of the refrigerant takes place and the liquid refrigerant collects.

When the heat applied to the boiler B reaches a temperature of 260° F., the indicator I drops as the result of the melting of some fusible metal in the tube t. At this signal, the application of heat

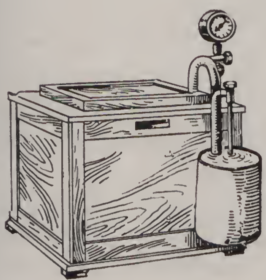

Fig. 152.—Portable absorption refrigerating unit.

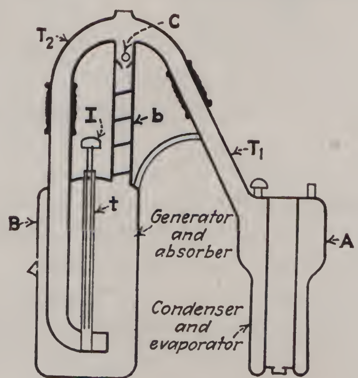

Fig. 153.—Generator and absorber of portable refrigerating unit.

is stopped, and the boiler is submerged in water in a tub or other suitably convenient vessel. This cooling by the water causes the pressure in the boiler to fall, and since the check valve C is closed, vapor of the refrigerant from the cooler A passes to the boiler B (generator) through the pipe T_2, from which it bubbles up into the weak liquor and is absorbed. After a few minutes of cooling in the water bath, the pressure in the boiler B falls to a point where refrigerating temperatures are produced in the cooler A, and the apparatus is then ready to be placed in a cabinet where it will serve for refrigeration. It can be successfully used in this way for freezing ice.

The heat required for heating the boiler can be obtained by burning gas, kerosene, alcohol, or a similar fuel. Before commencing each heating operation, it is necessary to drain the

condensation from the cooler *A* into the boiler *B* by leaving it for 5 or 10 minutes in such a position that the "cooler" is elevated above the level of the boiler.

Icy-ball Refrigerating Device.—An American-built refrigerating apparatus called "icy-ball," operated by a similar method, as illustrated in Figs. 154–158 was designed to produce refrigeration

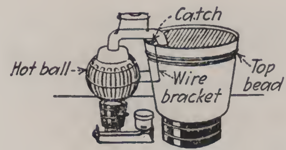

Fig. 154.

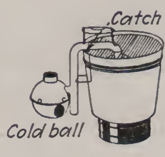

Fig. 155.

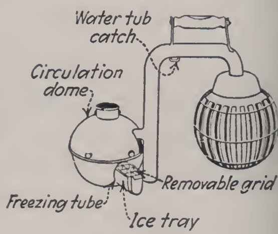

Fig. 156.

Fig. 154.—Icy ball being heated.
Fig. 155.—Icy ball being cooled.
Fig. 156.—Ice tray in icy ball.

more efficiently than the French types that have been explained. It weighs about 36 pounds and has an ice-melting capacity per "heat" of about 16 pounds. It is intended to be heated once a day in average summer weather.

In seeking ways to increase the capacity per unit of volume of similar French machines, the designers adopted the following

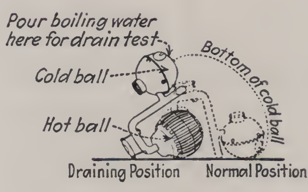

Fig. 157.

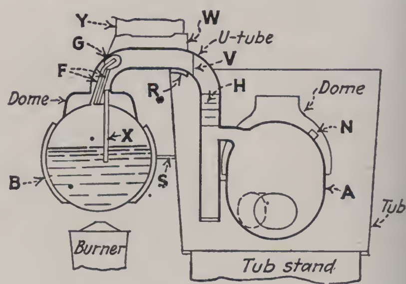

Fig. 158.

Fig. 157.—Draining and normal positions of icy ball.
Fig. 158.—Details of icy ball.

changes: (1) use of spherical shapes to obtain maximum weight of "charge" per unit of weight and volume; (2) increase of the ammonia concentration; (3) heating the boiler (hot ball) to a higher temperature than was customary in the other types. For a given pressure, the concentration could be increased by lowering the temperature of the aqua ammonia during the

absorption period, and this was effectively done by the addition of radiation fins on the side of the boiler (hot ball), as shown in Fig. 158. To obtain an advantage by heating the boiler (hot ball) to a higher temperature, adequate dehydration was provided by the method of adding a dome to the boiler *B* to the top of which the U-tube is attached. In this dome, a "strong" aqua-ammonia solution gathers and is boiled by the hot gases rising from the boiler below. Condensed water vapor and ammonia collects in the lower part of the U-shaped tube and is later returned to the boiler by the method to be explained. A non-return liquid seal is formed by the tubes *F* and the pocket *G*, the latter serving to absorb the surges of liquid refrigerant that occur when the refrigerating unit is handled. When this liquid seal has been formed, the vapor of the refrigerant returns to the boiler *B* through the tube *X*, and when bubbling up through the liquid is rapidly absorbed. The dome on the cooler *A* provides a circulation of water during the condensing period. The brackets *R* and *S* serve for hanging the refrigerating unit on the side of the tub. The boiler *B* and the cooler *A* are each made of two steel hemispheres about 0.08 inch thick and 10 inches in diameter. These units are tested with hydraulic pressure to 600 pounds per square inch. A safety device *N* consisting of the silver disk 0.0025 inch thick opens if excessive pressure develops. A needle valve *W* used in the initial charging of the refrigerating unit, which serves also as a handle bracket, is at the top of the U-tube. The other handle bracket *Y* is flared out so as to form two feet to support the refrigerating unit during the draining operation illustrated in Fig. 157. The charging operation at the factory includes pumping out the air in the system with an air pump so that a relatively high vacuum is established, and then putting the charge of refrigerant into the boiler (hot ball).

The first step in the operation of the "icy-ball" refrigerating device is to place the unit in the draining position (Fig. 157), so that the "cooler" (cold ball) will empty into the boiler. This draining is very important, because if any aqua-ammonia solution is left in the cold ball, it will not only raise the temperature in that part of the unit during the refrigerating period but will retain several times its weight of ammonia in solution at the end of the cycle. The next step is that of heating the hot ball, which is started by attaching the unit to the side of the tube containing the water to be used for condensing the refrigerant vapor in the

cold ball. Just as soon as the cold ball is in the water used for condensing, the burner can be lighted under the hot ball. About 1½ hours is needed for the heating period, overheating or underheating reducing the refrigerating capacity. Indefinite overheating has, however, no permanently troublesome effects on any of the parts, unless the temperature becomes so high that it burns off the galvanizing from the hot ball. In case the heating operation is far too rapid, the safety disk will open. When the heating operation is completed, the burner is removed and the unit lifted away from the tub, so that the hot ball (boiler) can now be lowered into the water. The unit is shown in this position in Fig. 155; the pressure now falls so rapidly that in 10 or 15 minutes the cold ball will reach a freezing temperature.

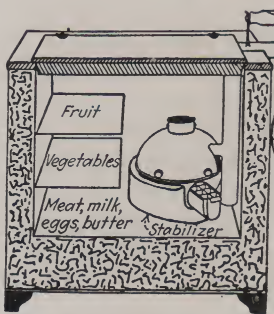

FIG. 159.—Cabinet for icy ball.

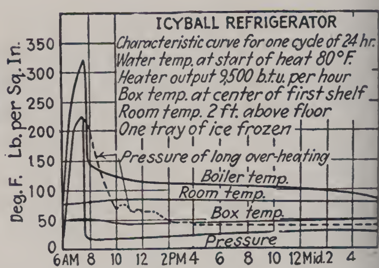

FIG. 160.—Tests of icy-ball equipment.

A cabinet supplied with the icy-ball equipment is shown in Fig. 159. This is a container shaped to fit around the lower half of the cold ball ("cooler"), and contains 15 pounds of anti-freeze solution of the kind commonly used in automobile radiators. This solution acts as a "thermal flywheel," by the method of transferring heat to the cold ball during the early stages of the refrigerating period and then later taking back heat from the air in the cabinet during the latter part of the refrigerating period, and also during the time that the icy-ball equipment is being prepared for another heat.

A typical operating cycle under test conditions of the icy-ball is shown in Fig. 160, showing the operating characteristics of the equipment for one complete cycle of 24 hours. When the outside-air temperature varied from 80 to 90° F. during the cycle, the temperature inside the cabinet varied from 40 to 50° F. and rose to a peak at 55° F. when the icy-ball was being heated. At

the same time, one tray of ice was frozen from water at an initial temperature of 80° F. The pressure in the icy-ball reached a maximum value of 225 pounds per square inch about three-fourths of the way through the heating period and was about 220 pounds per square inch at the end. Calorimeter tests show that the heat capacity of the equipment is about 2,300 B.t.u. per "heat."

This type of equipment is especially intended for places where there is a demand for modern refrigeration, and where electricity or gas services are not available.

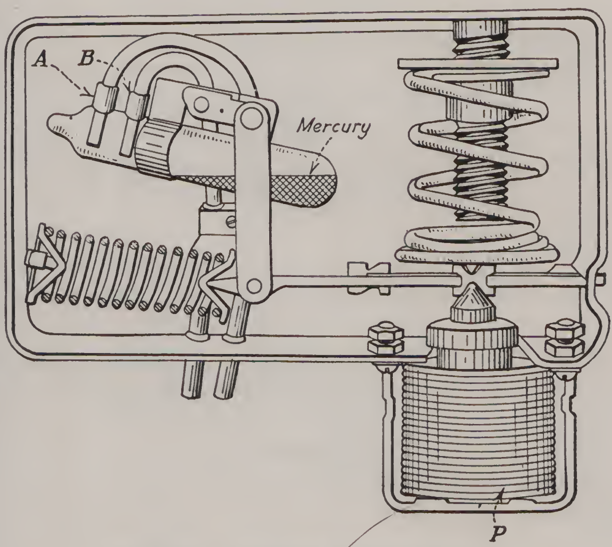

FIG. 161.—Mercoid electric switch.

Thermal Electric Switches.—Some electric switches are operated from a bimetallic thermostat; but are not successful, because it is difficult to make them operate on a temperature *range* as low as 4 or 5° F. An improved switch having a sylphon bellows operated by vapor pressure, called *mercoid control*, is shown in Fig. 161. This type of electric switch has recently found considerable application in refrigerating devices. It consists of a glass tube which contains a small amount of mercury that flows from one end to the other. When the mercury is at the left-hand end of the tube, the electric circuit is completed through the contact points *A* and *B*, and when it is tilted so that the mercury is at the right-hand end, as shown in the figure,